Shell Exploration & Production Company
3601 C Street, Suite 1334
Anchorage, AK 99503

January 12, 2007

National Marine Fisheries Service
Office of Protected Resources
Marine Mammal Division
Attn: James H. Lecky, Director
1315 East - West Highway
Silver Spring, MD 20910-3226

Subject: Request for Approval, Incidental Harassment Authorization for Non-Lethal Taking of Seals in the Beaufort Sea, Alaska in Conjunction with On-ice Marine Geophysical (Seismic) Research and Development Program During Spring 2007

Dear Mr. Lecky:

Shell Offshore Inc (SOI), a legal entity of Shell Exploration and Production Company proposes to conduct an on-ice marine geophysical (seismic) research and development (R&D) program during spring 2007. This program will occur on U.S Minerals Management Service (MMS) Outer Continental Shelf (OCS) lease blocks located offshore from Oliktok Point, Milne Point, West Dock, or Endeavor Island, in the Alaskan Beaufort Sea. We request an Incidental Harassment Authorization (IHA) pursuant to Section 101 (a) (5) (D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a) (5), to allow non-lethal takes of seals incidental to on-ice seismic operations.

This application has been revised based on comments provided by Shane Guan from the Office of Protected Resources Permits, Conservation and Education Division. SOI prepared a response to Mr. Guan's comments dated January 9, 2007 and held a conference call with him on January 11, 2007. Based on the results of these consultations with Mr. Guan, SOI has re-submitted the above-referenced IHA application.

SOI's IHA application identifies potential take(s) stemming from noise harassment as a result of the on-ice seismic operation vehicles. Surface sources will be a variety of industry-standard vehicles described as follows:

- Vibrators will include a 68,000 pound (lb) gross vehicle weight (GVW) wheeled vibrator (capable of 49,440 foot-pounds (ft-lbs) of force),
- 14,400 lb GVW wheeled mini-vibrator (capable of 12,000 ft-lbs of force).
- 25,300 lbs GVW all terrain vehicle to support a Polaris 860, and
- 17,000 lbs GVW buggy-type vehicle to support the Digipulse 1180.

Two impact sources will be used and are described as:

- Digipulse 1180 (1,200,000 ft-lbs),
- Polaris 860 (866,000 ft-lbs),
- An airgun will be used that can produce between 345,000 and 560,000 ft-lbs of force at 2,000 and 3,000 pounds per square inch (psi) respectively. The recording unit is comprised of 13 tracked vehicles for crew transport and technical support, 2 tracked recording trailers, and 2 ice drilling units.

The proposed Beaufort Sea on-ice seismic survey is scheduled to begin in early March 2007 with camp mobilization expected to begin March 10 from Oliktok Point, Milne Point, West Dock, or Endeavor Island (see attached Map). The camp should be established by March 15, and seismic acquisition will begin on or about March 17. Data acquisition will continue until May 5 to 10, followed by camp demobilization to Oliktok Point, Milne Point, West Dock, or Endeavor Island. This program is projected to take 30 to 40 days to acquire the necessary data. SOI held Plan of Cooperation meetings in the communities of Nuiqsut and Barrow on October 16-17, 2006, and presented this information at that time. Additional follow-up meetings are tentatively scheduled for late February or early March 2007 in both Barrow and Nuiqsut. Inupiat subsistence hunters will be hired to assist with clearing seismic line surveys, accompanying the lair-sniffing dogs, and as polar bear watch/hazers. These hunters will ensure that SOI's proposed activities, timing and location, will not interfere with access to subsistence resources.

Given the limited extent of the acquisition area and timing of the activities, any impacts on the seal populations of the Beaufort Sea on-ice seismic activity are likely to be short term and transitory in temporary displacement of individuals or small groups that may be exposed to seismic sounds at the >160 decibel (dB) received levels. The seismic activities will not result in any permanent impact on habitats used by marine mammals or their prey sources. There should be no adverse impacts on the availability of the seals for subsistence users.

Items presented pursuant to 50 C.F.R. § 216.104, "Submission of Requests", and § 216.107, "Incidental Harassment Authorization for Arctic Waters", are attached with the application.

Please contact me at (907) 646-7112 for further information or clarification.

Sincerely,
Shell Exploration & Production Company

Susan Childs
Regulatory Affairs Coordinator, Alaska

Attachments:

- Application for Incidental Harassment Authorization for the Non-lethal Taking of Seals in Conjunction with a Proposed On-ice Marine Geophysical Research and Development Program in the Beaufort Sea, Alaska, During Spring 2007

cc w/attachments:

Maggie Ahmaogak, Alaska Eskimo Whaling Commission - Barrow, AK
Doug DeMaster, NOAA Fisheries - Seattle, WA
Ken Hollingshead, NOAA Fisheries - Silver Spring, MD
Brad Smith, NOAA Fisheries - Anchorage, AK
Arnold Brower, Jr. - ICAS
Jeffrey Walker – MMS
Rance Wall – MMS
Don Perrin - ADNR
Mark Stone - Shell
Bob Rosenbladt – Shell
Mark Davidson - Shell

A. Michael Macrander – Shell
Greg Horner – ASRC Energy Services
Project File
Administrative File

15067-22.1.4.1.3/O6-214

Application for Incidental Harassment Authorization for the Non-Lethal Taking of Seals in Conjunction with a Proposed On-ice Marine Geophysical Research and Development Program in the Beaufort Sea, Alaska, During 2007

January 2007

Submitted to:

Shell Offshore Inc.
3601 C Street, Suite 1334
Anchorage, Alaska 99503

Prepared by

ASRC Energy Services
Lynx Enterprises, Inc.

3900 C Street, Suite 601
Anchorage, Alaska 99503

Table of Contents

Page

Figures

Tables

Attachments

Shell Offshore Inc. (Shell), a legal entity of Shell Exploration and Production Company, used the following guidance to prepare its request for Incidental Harassment Authorization (IHA):

> 50 CFR 216.104 "Submission of Requests"
>
> (a) In order for the National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. All requests must include the following information for their activity:

1. A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals:

Information required by 50 CFR § 216.104 (a):

Shell proposes to conduct an on-ice marine geophysical (seismic) research and development (R&D) program during the spring 2007 on U.S. Minerals Management Service (MMS) Outer Continental Shelf (OCS) lease blocks located offshore from Oliktok Point, Milne Point, West Dock, or Endeavor Island in the Alaskan Beaufort Sea (See Figure 1). This on-ice seismic R&D will consist of 35 linear miles of surveying within a 16 square kilometer (km^2) area. Sources and receivers will be placed above and below the ice in attempts to find pairings that provide the best mitigation of seismic noise (i.e. a 'flex wave') in a shallow marine environment where conventional seismic vessels cannot operate. A variety of instruments will be used to create a complete catalogue of data for development of noise mitigation techniques. Sources include standard and lightweight vibrators, accelerated weight drop (impact) sources on the ice and small volume airgun arrays deployed through holes augered in the ice. Receivers will be deployed both on the ice surface, as well as below the ice suspended in the water column and on the ocean floor.

Seismic Sources/Recording Units

Surface sources will be a variety of industry-standard vehicles (see Attachment A for list of equipment specifications). Vibrators will include a 68,000 pound (lb) gross vehicle weight (GVW) wheeled vibrator (capable of 49,440 foot-pounds [ft-lbs] of force) and a 14,400 lb GVW wheeled mini-vibrator (capable of 12,000 ft-lbs of force). Two impact sources will be used; a Digipulse 1180 (1,200,000 ft-lbs) and a Polaris 860 (866,000 ft-lbs). The Polaris Explorer 860 is a 25,300 lbs GVW all terrain vehicle capable of 860,000 lbs peak force output at the baseplate. The Digipulse 1180 will be mounted on a 17,000 lbs GVW buggy-type vehicle and the 1180 is capable of 1,152,000 lbs peak force output at baseplate. Sercel Generator/Injector (GI) airguns will be used and can produce between 345,000 and 560,000 ft-lbs of force at 2,000 and 3,000 pounds per square inch (psi), respectively. The recording unit is comprised of 13 tracked vehicles for crew transport and technical support, two tracked recording trailers, and two ice drilling units.

Impact Source Modeling

Digipulse 1190 and Polaris 860 are both very new instruments. SOI is not aware of source level measurements of these units, but both units have dominant frequency ranges of 10-90Hz.

Airgun Seismic Source Modeling

SOI is developing a model of the GI guns with JASCO, a source-modeling company. Preliminary results for firing pressures of 2,000 psi and 3,000 psi are available. The following values relate to a single 210-cu in GI gun in harmonic mode fired at 2000 psi and 3,000 psi. Dominant frequency for a 210 cu in GI gun is given in literature as 0-188 Hz.

Model Input specifications:
Gun Type: 210 cubic inch GI gun
Primary chamber: 105 cubic inch
Injector chamber: 105 cubic inch
Firing depth: 6 m
Firing pressure: 2000 psi
Injector delay: 49 ms

Results Peak Pressure:

2.52 bar-m

228 dB re µPa at 1m

36.6 psi at 1m.

Model Input specifications::
Gun Type: 210 cubic inch GI gun
Primary chamber: 105 cubic inch
Injector chamber: 105 cubic inch
Firing depth: 2 m
Firing pressure: 3000 psi
Injector delay: 56 ms
Results Peak Pressure:
3.94180 bar-m
231.914 dB re uPa @ 1m
57.1710 psi at 1m

Temporary Field Camp

The program will require a temporary camp facility geared to accommodate up to 100 people and will be composed of purpose-built accommodations which are largely self-sufficient for normal operations. Camp facilities may include as many as 35 sled trailers including medical facilities, crew quarters, offices, kitchen and dining facilities, laundry facilities, technical work spaces, generators, and fuel storage units. Two tracked vehicles will be available for camp site support and access trail maintenance. Prospective camp locations will be chosen based on ice conditions and safety of access to ice. These locations will be moved within the area outlined in Figure 1; MMS and NMFS will be consulted. Mobilization and demobilization will take place from West Dock, Oliktok Point, Milne Point or Endeavor Island (Figure 1). Given the logistics, it is unlikely that the operations would utilize each of the four prospective camp locations. The camp will be stationed on grounded ice beside the access route. KuukpikVeritas will begin conducting surveys and ice checks and move the camp 7 to 12 days ahead of the seismic survey along the route away from the mobilization point. Re-supply operations will periodically be required for fuel and provisions. These operations will be based out of West Dock, Oliktok Point, Milne Point or Endeavor Island.

2. The dates and duration of such activity and the specific geographic region where it will occur:

Prior to seismic testing, ice verification is scheduled to begin late February to early March 2007. The extent, thickness, and integrity of the ice will be measured using satellite imagery, ground penetrating radar, and grid pattern drill holes. A minimum ice thickness of 4 feet is required in order to support the vibroseis and recording equipment.

Camp mobilization is expected to begin March 10, 2007. By March 15, the camp should be established and seismic acquisition will begin on or about March 17. Data acquisition will continue until May 5 to 10, followed by camp demobilization to Oliktok Point, Milne Point, West Dock or Endeavor Island. The program is projected to take 30 to 40 days to acquire the necessary data.

The proposed program locations are outlined in Figure 1. The prospective locations have been selected on the basis of suitability for the scientific testing and proximity to facilities to help minimize impact on the region. The water depth at each location is less than 20 meters (m) (66 feet); deep enough that the ice is not grounded. Additionally, these locations are designed to be landward of the ice pressure ridges that form between the stable and pack ice. Final location will depend on a combination of suitable ice conditions, operational efficiency, and location away from permit restrictions (e.g. seal dens, etc.). Final determination of project placement is expected in early March.

Ice conditions within the proposed survey areas will determine the areas selected; MMS and NMFS management personnel will be consulted.

3. Species and Numbers of Marine Mammals in Area:

The species and numbers of marine mammals likely to be found within the Eastern Beaufort Sea activity areas are listed in Table 4-1.

A total of 3 species of pinnipeds (ringed, spotted, and bearded seal), and one marine carnivore (polar bear) are known to occur in or near the proposed study area. Polar bear abundance is addressed under an application for incidental harassment to the U.S. Fish and Wildlife Service (USFWS) under the Beaufort Sea regulations.

In an effort to reduce redundancy, we have included the required information about these species and abundance estimations (to the extent known) of these species in Section 4 below.

4. Status, Distribution and Seasonal Distribution of Affected Species or Stocks of Marine Mammals:

Three species of pinnipeds — the ring sea, spotted seal, and bearded seal — managed as trust species by the NMFS will occur within the project activity area in the Beaufort Sea. Discussions of abundance of these species are included in this section and included in Table 4-1. Abundance of the polar bear is included in Table 4-1, given its prevalence in the area but is not discussed further under the species discussions.

TABLE 4-1
List of species, their habitats, conservation status, and estimated populations inhabiting the proposed seismic activity areas located in the eastern portion of the Beaufort Sea.

Species (Stock)	Habitat	Beaufort Sea Stock and/or ESA Status [1]	Estimated Abundance [2/]
Pinnipeds			
ringed seal (*Phoca hispida*) (Alaska)	Landfast and pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Up to 3.6 million; Currently, no reliable abundance estimate is available for the Beaufort Sea, however, combined with surveys from the Chukchi Sea, approximately 249,000 are estimated.
spotted seal (*Phoca largha*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Several thousand and several tens of thousands. An estimate with correction using 1992 data = 59,214 seals but is preliminary at best.
bearded seal (*Erignathus barbatus*)	Pack ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Currently, no reliable abundance estimate is available for this stock. Early estimates of the Bering-Chukchi Seas ranged from 250,000 to 300,000.
Carnivora			
polar bear (*Ursus maritimus*)	Coastal, ice	Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock	Population estimates for the Southern Beaufort Sea population of northern Alaska is 2,272 bears.

1. ESA = Endangered Species Act. Stocks listed as depleted under the MMPA (Marine Mammal Protection Act) is described as any stock that falls below its optimum sustainable population must be classified as "depleted," 16 U.S.C. § 1362(1)(A). The numeric threshold for Optimum sustainable population (OSP) has been interpreted by NMFS and FWS as being above 0.6 K (i.e. greater than 60% of K, or carrying capacity). In other words, a stock that dropped in numbers to below 60% of K would qualify as "depleted" under the MMPA. The term "strategic stock" is defined as a marine mammal stock: (A) for which the level of direct human-caused mortality exceeds the Potential Biological Removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act of 1973 . . . within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the Endangered Species Act of 1973 . . ., or is designated as depleted under [the MMPA].
2. See text under individual species for population estimate source.

Ringed Seal (*Phoca hispida*)

In the North Pacific, ringed seals are found in the southern Bering Sea and range as far south as the Seas of Okhotsk and Japan. Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying seasonal and permanent ice, and are year-round residents throughout the Beaufort, Chukchi, and Bering Seas, as far south as Bristol Bay in years of extensive ice coverage. They tend to prefer large floes (>48 m in diameter) and are often found in the interior ice pack where the sea ice coverage is greater than 90% (Simpkins et al. 2003), and remain in contact with ice most of the year and pup on the ice in late winter-early spring.

During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi, and Beaufort Seas. Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They give birth in lairs from mid-March through April, nurse their pups in the

lairs for 5–8 weeks, and mate in late April and May (Smith 1973; Hammill et al. 1991; Lydersen and Hammill 1993).

During late April through June, ringed seals are distributed throughout their range from the southern ice edge northward (Braham et al. 1984). Preliminary results from recent surveys conducted in the Chukchi Sea in May-June 1999 and 2000 indicate that ringed seal density is higher in nearshore fast and pack ice, and lower in offshore pack ice (Bengtson et al. [in review] *cited in* Angliss and Outlaw 2005). Frost and Lowry (1999) conducted surveys in May and results indicated that, in the Alaskan Beaufort Sea, the density of ringed seals in May-June is greater to the east of Flaxman Island than to the west.

No estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Outlaw 2005). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1 to 3.6 million (Frost et al. 1988). Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter.

Aerial surveys within 20 nautical miles (nm) of shore were conducted in May-June between 1986 and 1987 for a portion of the range of the ringed seal estimated 44,360 +/-9,130 (96% CI) (Frost et al. 1988). Spring density estimates in the same area from 1985-1987 ranged from 1.01 to 2.94 seals/km^2 (Frost et al. 1988). Similar surveys for the Alaska Beaufort Sea between Kaktovik and Barrow occurred in the spring during several years in the 1990s with density estimates for all years ranging from 0.81-1.17 seals/km^2 with a mean of 0.98 seals/km^2 or approximately 18,000 hauled out ringed seals in the survey area. Surveys conducted in 1999 and 2000 between Shishmaref to Barrow in the eastern Chukchi Sea estimated abundance of ringed seals at 252,488 (SE = 47,204) and 208,857 (SE = 25,502), respectively (Bengtson et al. [in review] *cited in* Angliss and Outlaw 2005). Combining this with the average abundance estimate of 230,673 seals from the eastern Chukchi Sea, results in a total of 249,000 seals.

It is not known whether the more recent lower densities correspond to an actual reduction in the population or are related to earlier survey dates in 1990s. At earlier dates, a higher proportion of the seals are still using their lairs and are unavailable to be counted by aerial surveyors (Kelly et al. 1998). Frost et al. (2002) reanalyzed the earlier estimates for 1985-87 and reported ringed seal densities surveyed between Oliktok Point and Flaxman Island ranged from 0.56 to 1.16 seals/km^2 (about half the density originally reported) during the spring seasons of 1985 to 1987. Based on more recent surveys from 1996 through 1999, ringed seal density in fast ice areas between Oliktok Point and Flaxman Island ranged from 0.48 to 0.77 seals/km^2 (Frost et al. 2002).

British Petroleum (Alaska) Inc. (BP)'s Northstar project, located near Prudhoe Bay, developed a seal survey and monitoring program to establish a baseline prior to construction and to monitor during initial operations for comparison. Ringed seal densities reported by Moulton et al. (2002) ranged from 0.39 to 0.63 seals/km^2 prior to construction in the Northstar development area. Ringed seal densities close to Northstar in 2000, 2001, and 2002 were not reduced relative to those farther away or to those during the 1997 to 1999 pre-development period (Moulton et al. 2003 a, b), however, because aerial surveys will underestimate actual seal densities, the above density figures should be used as minimum estimates.

Large concentrations of ringed seals are not expected to be encountered near the proposed seismic activity area during the late March to early May time period. The Alaska stock of ringed seals is not classified as a strategic stock by the NMFS.

Spotted Seal (Phoca largha)

Spotted seals occur in the Beaufort, Chukchi, Bering and Okhotsk Seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). Based on satellite tagging studies, spotted seals migrate south from the Chukchi Sea in October and pass through the Bering Strait in November and overwinter in the Bering Sea along the ice edge (Lowry et al. 1998). As can be discerned from the

following, spotted seals are not assumed to be present in the Beaufort Sea at the time of the proposed on-ice seismic program.

In summer, the majority of spotted seals are found in the Bering and Chukchi Seas, but do range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. The seals are most commonly seen in bays, lagoons, and estuaries and are typically not associated with pack ice unless it is near to shore.

A small number of spotted seal haul-outs are documented in the central Beaufort Sea near the deltas of the Colville River and, previously, the Sagavanirktok River. Historically, these sites supported as many as 400 to 600 spotted seals, but in recent times less than 20 seals have been seen at any one site (Johnson et al. 1999).

As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

Previous studies from 1996 to 2001 indicate that few spotted seals (a few tens) utilize the central Alaskan Beaufort Sea (Moulton and Lawson 2002; Treacy 2002 a, b). In total, there are probably no more than a few tens of spotted seals along the coast of the central Alaska Beaufort Sea during summer and early fall with very few, if any, occurring in the eastern portion of the Beaufort Sea.

A reliable abundance estimate for spotted seal is not currently available (Angliss and Outlaw 2005), however, early estimates of the size of the world population of spotted seals was 335,000 to 450,000 animals and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Burns 1973 *cited in* Angliss and Lodge 2004). The total number of spotted seals in Alaskan waters is not known (Angliss and Lodge 2004), but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). Using maximum counts at known haulouts from 1992 (4,135 seals), and a preliminary correction factor for missed seals developed by the Alaska Department of Fish and Game (Lowry et al. 1998), an abundance estimate of 59,214 was calculated for the Alaska stock (Angliss and Lodge 2004).

As stated above, the activities associated with this proposed on-ice seismic work is expected to encounter few to no spotted seals. The Alaska stock of spotted seals is not classified as a strategic stock by NMFS.

Bearded Seal (Erignathus barbatus)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981). Bearded seals are predominately benthic feeders, and prefer waters less than 200 m in depth.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter they are most common in broken pack ice and in some areas also inhabit shorefast ice (Smith and Hammill 1981). In Alaska waters, bearded seals are distributed over the continental shelf of the Bering, Chukchi, and Beaufort Seas, but are more concentrated in the northern part of the Bering Sea from January to April (Burns 1981).

During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort Seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter. From mid- to late-April to June, as the ice recedes, some of the bearded seals migrate northward through the Bering Strait and spend the summer along the ice edge in the Chukchi Sea (Burns 1967; Burns 1981).

Recent spring surveys along the Alaskan coast indicate that bearded seals tend to prefer areas of between 70 and 90 percent sea ice coverage, and are typically more abundant greater than 20 nm off shore, with

the exception of high concentrations nearshore to the south of Kivalina in the Chukchi Sea (Bengtson et al. 2000; Simpkins et al. 2003).

A reliable abundance estimate for the Alaska stock of bearded seals is currently not available. The most recent surveys occurred in May-June of 1999 and 2000 between Shismaref and Barrow with average densities of 0.07 seals per km^2 and 0.14 seals per km^2, respectively, however, there is no correction factor available for these data. Early estimates of the Bering-Chukchi Sea population ranged from 250,000 to 300,000 (Burns 1981).

No reliable estimate of bearded seal abundance is available for the Beaufort Sea (Angliss and Lodge 2002). Aerial surveys conducted by Minerals Management Services in fall 2000 and 2001 sighted a total of 46 bearded seals during survey flights conducted between September and October (Treacy 2002 a, b), with all but two sightings recorded east of 147ºW and all sightings were within 40 nm of shore. Aerial surveys conducted from 1997 to 2002 in the vicinity of Northstar Island also reported small numbers (up to 15) of bearded seals (Moulton et al. 2003c).

The activities associated with this proposed seismic work is expected to encounter few to no bearded seals. The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

5. The type of incidental taking authorization that is being requested (i.e. takes by harassment only; takes by harassment, injury and/or death) and the method of incidental taking:

The only type of incidental taking sought in this application is that of takes by noise harassment. The sources of harassment will be those noises produced by operation of a variety of industry-standard vehicles. Vibrators will include 4 - 68,000 lb GVW (wheeled) and 2 - 98,000 lb GVW (tracked) vibrators, 2 - 14,400 lb GVW mini-vibrators (wheeled), and 1 - 4 impact sources (wheeled or tracked). Sub-ice sources (small volume airgun arrays) will be deployed through a purpose-modified, tracked vehicle.

6. Numbers of marine mammals that may potentially be taken:

Shell seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the proposed region of activity. Species for which authorization is sought are ringed, spotted, and bearded seals.

The only anticipated impacts to marine mammals, in this case seals, associated with noise propagation during seismic acquisition operations would be the temporary and short term displacement of seals from within ensonified zones produced by such noise sources. Measures to mitigate impact to seals are discussed more completely in Section 11 of this IHA application.

Avoidance of ringed seal lairs is the greatest single impact to mitigate, since the proposed on-ice seismic program includes a period of time when ringed seal pups will be in birthing lairs beyond the landfast, and bottom-fast ice. E.M.C. Eco Marine Corporation and Drakeheath Kennels (Eco Marine) are proposed to accompany the seismic R&D program with ringed seal lair sniffing Labrador retrievers. Labrador retrievers are used to find ringed seal breathing holes and lairs under the snow in advance of the laying out of seismic lines and seismic acquisition equipment. The monitoring approach of Eco Marine is discussed further under Section 13 of this IHA application.

The proposed area of seismic acquisition for the Beaufort Sea proposed by Shell is not expected to "take" more than small numbers of marine mammals.

Basis for Estimating Numbers of Marine Mammals that Might be "Taken by Harassment"

Taking into account the small total volume and relatively-low sound output of the airgun sources, and planned mitigation measures, effects on pinnipeds are generally expected to be limited to avoidance of a small area (ensonification zone) around the seismic operation and short-term changes in behavior, falling within the MMPA definition of "Level B harassment".

The methods to estimate "take by harassment" and present estimates of the numbers of marine mammals that might be affected during the proposed seismic acquisition area in the Beaufort Sea are described below. Density estimates are calculated from relevant studies on ringed seal estimates including Stirling et al. (1982), Kingsley (1986).

This section provides estimates of the number of potential "exposures" to sound levels greater than 160 decibels (dB) re 1 μPa (rms). The greater than 160 dB criterion is applied for all species of pinnipeds .

The following estimates are based on a consideration of the number of marine mammals that might be disturbed appreciably by a 16 km^2 seismic survey conducted over and under ungrounded ice sitting atop less than 20 m of water. Seismic data source descriptions including energy expressed as force and data point frequency are as follows:

- 60,000 lb Vibrator – 49,440 ft lbs (218 kN); 320 vibroseis points per mile
- Mini-Vibrator – 12,000 ft lbs (53 kN); 320 vibroseis points per mile
- Digipulse 1180 (Impact Source): 1.2 MM ft-lbs (5300 kN); 320 impacts per mile
- Polaris 860 (Impact Source): 866,000 ft-lbs (3825 kN); 320 impacts per mile
- Airgun: One to two (2), Sercel GI airguns to be used; maximum output 210 in^3 each and sequentially energized; 320 shots per mile

Pinnipeds

Ringed, spotted, and bearded seals are associated with sea ice, and most census methods used to determine density estimates for pinnipeds are associated with counting the number of seals hauled out on ice.

TABLE 6-1
Expected densities of marine mammals during the winter seismic test program proposed for offshore areas of the Beaufort Sea

Species	Average Density (#/km^2) [1]	Maximum Density (#/km^2) [1]
Pinnipeds		
ringed seal	0.251	0.92
spotted seal	0.0001	0.0005
bearded seal	0.0128	0.0226

1. These estimates are calculated from various sources including Moore et al. 2000, Stirling et al. 1982, Kingsley 1986, and presented in LGL 2005, Table 4.

Correction factors have been developed for most pinniped species that address biases associated with detectability and availability of a particular species. Extensive surveys of ringed and bearded seals have been conducted in the Beaufort Sea, the majority of which have been conducted over the landfast ice. The most comprehensive survey dataset on ringed seals (and bearded seal) from the central and eastern Beaufort Sea was conducted on offshore pack ice in late spring (Kingsley 1986).

The estimated numbers of potential exposures presented in Table 6-2 are based the sound source range (i.e., >160 dB re 1 μPa (rms)), for most pinnipeds, the 160 dB threshold should be used to determine "take by harassment" because this range is assumed to be the sound source level at which most pinnipeds may change their behavior in reaction to increased sound exposure.

The number of exposures of a given species to sound levels between 160dB and 190 dB re 1 μPa (rms) is calculated by multiplying:

- The expected species density (i.e. average and maximum) shown in Table 6-1,
- The anticipated total line-kilometers of operations with the described equipment (i.e. 56 km),
- The cross-track distances within which received sound levels are predicted.

Estimated sound propagation distances for designated decibel ranges are based upon Beaufort Sea sound verification measurements (Greene, 2006) for airguns that are similarly sized to those to be used in the described research project. During Shell's operations in the Beaufort Sea in 2006, a Source Sound Verification (SSV) test was conducted to measure the output of the seismic source of the M/V Henry Christoffersen. These measurements were conducted August 8, 2006 at a location about 54 km east of Kaktovik at a location with a water depth of about 48 m (Greene, 2006).

During this SSV autonomous seafloor acoustic recorders, model B (ASAR-Bs) were deployed in the water column while the Henry Christoffersen sailed past with its seismic source operating. The seismic source on the Henry Christoffersen was a cluster of four 60-cu.in. airguns. The resulting data were converted into a sound level, offset relationship using an analysis technique which was designed to estimate the distance at each sound level such that almost all of the readings at a given sound level are at distances less than or equal to the estimated distance. This method was chosen so that calculated safety radii for marine mammal m itigation would be at the upper end of distances at a given sound level.

The resulting cross-track propagation distances for a given sound level are:

190 dB re 1 μPa rms	0.12 km
180 dB	0.33 km
170 dB	0.88 km
160 dB	2.22 km

These radii measured for a 240 cubic inch array are used here as an analog for the 210 cubic inch GI airgun to be used in this research project, as field measurements in the Beaufort Sea do not exist for the GI airgun source.

The cross-track propagation distances 0.12 km at 190 dB, 0.33 km at 180 dB, 0.88 km at 170 dB, and 2.22 km at 160 dB were used for exposure calculations for pinnipeds (see Table 6-2). This is a conservative estimate of sound propagation, as the presence of ice cover reduces sound propagation due to its rough under surface which scatters sound waves. Propagation tendencies of other sound producing equipment has not been previously measured, but is assumed to be similar, or less than, that of airguns, as equipment has been sized consistently in terms of energy production.

TABLE 6-2
Exposure Calculations for Pinnipeds

Decibel Levels		190 dB	180 dB	170 dB	160 dB	
Pinniped Species	**Average Density (#/km ^{2})**	0.12[1]	0.33[1]	0.88[1]	2.22[1]	**Requested take authorization**
Estimated Exposures						
Ringed Seal	0.251	4	10	25	63	
Spotted Seal	0.0001	1	1	1	1	
Bearded Seal	0.0128	1	1	2	4	

		190 dB	180 dB	170 dB	160 dB	
Pinniped Species	**Maximum Density (#/km^2)**	0.12[1]	0.33[1]	0.88[1]	2.22[1]	
Estimated Exposures						**229**
Ringed Seal	0.92	13	35	91	229	
Spotted Seal	0.0005	1	1	1	1	**1**
Bearded Seal	0.0228	1	1	3	6	**6**

[1] Cross-track propagation distances.

Exposure Calculations for Pinnipeds

Ringed seals would be the most prevalent marine mammal species encountered at the seismic acquisition areas, and would account for over 80 to 84 percent of the marine mammals that might be exposed during the seismic operations. The sounds from energy produced by vibrators used during on-ice seismic programs typically are at frequencies well below those used by ringed seals to communicate (1,000 hertz [Hz]). There has been no major displacement of seals away from on-ice seismic operations (Frost et al. 1988). Further confirmation of this lack of major response to industrial activity is illustrated by the fact that there has been no major displacement of seals near the Northstar Project. Studies at Northstar have shown a continued presence of ringed seals throughout winter and creation of new seal structures (Moulton et al. 2003b). Thus, ringed seal hearing is not likely to be very good at those frequencies and seismic sounds are not likely to have strong masking effects on ringed seal calls.

This effect is further moderated by the quiet intervals between seismic energy transmissions. Under this IHA, the requested take authorization for all pinnipeds uses the maximum density of greater than 160 dB. This decision to use the lower estimated number is based on the theory that surveys for pinnipeds within the Beaufort Sea, and elsewhere, are based on on-ice counts.

Spotted and bearded seals may be encountered in much smaller numbers than ringed seals, but also have the potential for exposure.

Summary

The proposed test program area north of Oliktok Point, Milne Point, West Dock or Endeavor Island in the Beaufort Sea will involve a variety of seismic source and receiver combinations will be used to evaluate seismic acquisition and data analysis methods to address the flex wave and other noises found when surveying over ungrounded ice. Taking into account the small total volume and relatively low sound output of the airgun sources, and planned mitigation measures, effects on pinnipeds are generally expected to be limited to avoidance of a small area around the seismic test area and short-term changes in behavior, falling within the MMPA definition of "Level B harassment". The requested "take

authorization" for each species is based on the estimated *maximum number of exposures* to ≥160 dB re 1 μPa (rms) for pinnipeds (i.e., the highest of the various estimates where a behavioral change may be expected). In addition, the estimated numbers of animals potentially exposed to sound levels sufficient to cause appreciable disturbance are very low percentages of the population sizes in the Beaufort Sea. Source level monitoring will be conducted using an approach discussed in Section 13 of this application.

No reliable abundance numbers currently exist for ringed, spotted, and bearded seals for the Beaufort Sea, however, the potential number of exposures would be a very small fraction of earlier abundance estimates.

The short-term exposures to airgun sounds are not expected to result in any long-term negative consequences for individual pinnipeds or their populations.

A 90 day report will be prepared and submitted to NMFS in accordance with the IHA requirements.

7. The anticipated impact of the activity on the species or stock:

The only anticipated impacts to marine mammals associated with noise propagation from equipment movement and seismic airgun operations would be the temporary and short term displacement of seals within ensonified zones produced by such noise sources. Any impacts on the seal populations of the Beaufort Sea seismic acquisition activity area are likely to be short term and transitory arising from the temporary displacement of individuals or small groups from locations they may occupy at the times they are exposed to seismic sounds at the >160 dB received levels. As noted in section 6, above, it is highly unlikely that animals will be exposed to sounds of such intensity and duration as to physically damage their auditory mechanisms.

8. The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses:

The various pinniped species are all taken by subsistence hunters of the eastern Beaufort Sea villages. The planned marine on-ice seismic operations will not adversely affect the usual haul-out locations of these species. Pinniped (ringed seal) lairs could be temporarily abandoned when seismic activity is occurring in close proximity, thus avoidance of the lairs is the planned approach. Trained dogs will be used to locate ringed seal lairs before the onset of seismic activities. During the seal pupping season, planned seismic line segments will be surveyed via the research biologists teamed with lair sniffing dogs; these teams will be accompanied by Inupiat subsistence hunters experienced in the area of the project.

9. Anticipated impact on habitat:

The seismic activities proposed will not result in any permanent impact on habitats used by marine mammals, or to their prey sources.

A broad discussion on the various types of potential effects of exposure to seismic on invertebrates can be found in LGL (2005), and includes a summary of direct mortality (pathological/physiological) and indirect (behavioral) effects.

Limited studies on physiological effects on marine fish and invertebrates to acoustic stress have been conducted. No significant increases in physiological stress from seismic energy were detected for various fish, squid, and cuttlefish (McCauley et al. 2000) or in male snow crabs (Christian et al. 2003). Behavioral changes in fish associated with seismic exposures are expected to be minor at best. Because only a small portion of the available foraging habitat would be subjected to seismic pulses at a given time, fish would be expected to return to the area of disturbance anywhere from 15-30 minutes (McCauley et al. 2000) to several days (Engas et al. 1996).

Available data indicates that mortality and behavioral changes do occur within very close range to the seismic source, however, the proposed low volume airgun arrays to be used is predicted to have a negligible effect to the prey resource available to pinnipeds occurring during the project's 40-day duration covering only a 16 km^2 area.

10. Anticipated impact of habitat loss or modification:

The total footprint of the proposed seismic survey area covers approximately 16 km^2. The effects of the planned seismic activity at the locations on marine mammal habitats and food resources are expected to be negligible, as described in Section 9. It is estimated that only a small portion of the animals utilizing the areas of the proposed activities would be temporarily displaced. During the period of seismic acquisition (spring 2007), seals would be dispersed throughout the area.

The proposed activities are not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat due to the limited extent of the acquisition area and timing of the activities.

11. The availability and feasibility (economic and technological), methods, and manner of conducting such activity or means of effecting the least practicable impact upon affected species or stock, their habitat, and of their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance:

The following mitigations are proposed:

- The timing and locations for active seismic acquisition work will be scheduled to be initiated and completed at a time of year that has the potential to least affect marine mammals, specifically the ring seal;
- To configure airguns in a manner that directs energy primarily down to the seabed thus decreasing the range of horizontal spreading of seismic noise;
- Use low volume airguns as an energy source;
- Soft-start ramp-ups will be conducted;
- Use seal lair sniffing dogs to locate lairs before the seismic programs begins so that the lairs may be avoided.

12. Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock or marine mammal for Arctic subsistence uses, the applicant must submit a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

i. A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation.

ii. A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation.

iii. A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

iv. What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

- A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation.

  Plan of Cooperation meetings in the communities of Nuiqsut and Barrow occured on October 16-17, 2006. Additional follow-up meetings are tentatively scheduled for May or June 2007 in the affected communities.

- A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation.

  Shell held community meetings with the affected Beaufort Sea communities in mid-October 2006 and will hold meetings again in early 2007.

- A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing;

  Inupiat subsistence hunters will be hired to assist with clearing seismic line surveys, accompanying the lair-sniffing dogs, and as polar bear watch/hazers. These hunters will ensure that Shell's proposed activities, timing and location, will not interfere with access to subsistence resources.

- What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

  Plan of Cooperation meetings will be held in spring 2007 in the affected communities. In addition, the applicant can meet with North Slope officials and community leaders on an as-requested basis before the proposed on-ice seismic activities.

13. The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on the population of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding:

As mentioned above, avoidance of seal lairs will be mitigated through the use of seal lair sniffing dogs. Locations of lairs will be monitored and adjustments to the seismic operation will be made when necessary. It should be noted that all sightings of polar bears acquired by observers will be recorded and reported to the USFWS.

Eco Marine's Dr. Thomas G. Smith will use trained dogs to locate seal structures under snow (subnivean). The recommended prospective area for the seismic research project will be surveyed for the subnivean seal structures using three trained dogs running together. These dogs precede Eco Marine representatives traveling by sled. Transects are spaced 250m apart and oriented 90° to the prevailing wind direction. The search tracks of the dogs are recorded by GPS units on the dogs and the tracks are downloaded daily.

Subnivean structures located are probed by steel rod to check if each is open (active), or frozen (abandoned). Structures are categorized by Eco Marine by size, structure and odor to ascertain whether the structure is a birth lair, resting lair, resting lair of rutting male seals, or a breathing hole.

Source Level Monitoring

Seismic sources for the program will be recorded into five sensor groups: analog surface receivers, digital surface receivers, hydrophones in the water column, and two different types of 4-component ocean bottom sensors on the seafloor. Each source will be recorded into the five receiver groups. Water-column monitoring of sound levels will be most directly accomplished by monitoring sound levels from the hydrophones. Density of receivers is very high – station spacing is 5m, so a detailed characterization of the sound levels can be accomplished. A range of receiver offsets will be available up to the maximum program offset of 4000m. Additionally, the surface and ocean bottom sensors can be used as supplemental information in the determination of source levels and propagation distances for the experiment.

NMFS and SOI are proposing a 500m exclusion zone around all located active subnivean seal structures. During active seismic and impact source testing an on-ice 500m exclusion zone will be monitored for entry by any marine mammal. No seismic or impact surveys will be conducted if a marine mammal is observed entering the monitored exclusion zone. Soft-start ramp up procedures also will be used. Monitoring of active seismic spreads can be conducted by trained field crew members also tasked with polar bear watch and guard.

14. Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects:

Shell is prepared to share information obtained during implementation of our marine mammal monitoring program with a variety of groups who may find the data useful in their research. A suggested list of recipients includes:

- The North Slope Borough Department of Wildlife Management (Craig George)
- The USFWS Office of Wildlife Management (Craig Perham)
- The Kuukpik Subsistence Oversight Panel (KSOP) (Nuiqsut)
- The City of Nuiqsut
- Alaska Eskimo Whaling Commission (Barrow)
- Alaska Native Ice Seal Committee
- Inupiat Community of the Arctic Slope (ICAS) (Barrow)
- North Slope Science Initiative (Ken Taylor)

Cited References

Angliss, R.P. and K.L. Lodge. 2002. *Alaska Marine Mammal Stock Assessments, 2002.* U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-133, 224 p.

Angliss, R.P. and K.L. Lodge. 2004. *Alaska Marine Mammal Stock Assessments, 2003.* U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-144. 230 p.

Angliss, R.P. and R. Outlaw. 2005. *Draft Marine Mammal Stock Assessment Reports (SARS) by Species/Stock.* Draft Reports 2005, revised July 2005. NMFS. AFSC Center. Seattle, WA. 229 p. Available online at: http://www.nmfs.noaa.gov/pr/readingrm/MMSARS/draft05alaskareportall.pdf

Bengtson, J.L., P.L. Boveng, L. M. Hiruki-Raring, K.L. Laidre, C. Pungowiyi, and M.A. Simpkins. 2000. *Abundance and Distribution of Ringed Seals (Phoca hispida) in the Coastal Chukchi Sea.* Pp. 149-160. In A. L. Lopez and D. P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Report 2000-11, 195 pp.

Braham, H.W., B.D. Krogman and G.M. Carroll. 1984. *Bowhead and White Whale Migration, Distribution, and Abundance in the Bering, Chukchi, and Beaufort Seas, 1975-78.* NOAA Tech. Rep. NMFS SSRF-778. USDOC/NOAA/NMFS. 39 p. NTIS PB84-157908.

Burns, J.J. 1967. *The Pacific Bearded Seal.* Alaska Department of Fish and Game, Pittman-Robertson Proj. Rep. W-6-R and W-14-R. 66 pp.

Burns, J.J. 1981. *Bearded Seal Erignathus barbatus Erxleben*, 1777. p. 145-170 In S.H. Ridgway and R.J. Harrison (eds.), Handbook of Marine Mammals. Vol. 2. Seals. Academic Press, New York.

Christian, J.R., A. Mathieu, D.H. Thomson, D. White and R.A. Buchanan. 2003. *Effect of Seismic Energy on Snow Crab* (*Chionoecetes opilio*). Rep. from LGL Ltd., St. John's, Nfld., for Environ. Stud. Res. Fund (ESRF), Calgary, Alta. 56 p. + App.

Engås, A, S. Løkkeborg, E. Ona and AV. Soldal. 1996. *Effects of Seismic Shooting on Local Abundance and Catch Rates of Cod (G. morhua) and Haddock (M. aeglefinus).* Can. J. Fish. Aquatic. Sci. 53(10):2238-2249.

Frost, K.J. and L.F. Lowry. 1981. *Foods and Trophic Relationships of Cetaceans in the Bering Sea*. p. 825-836 In: D.W. Hood and J.A. Calder (eds.) The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. 2. Univ. Wash. Press, Seattle.

Frost, K.J., L.F. Lowry, J.R. Gilbert, and J.J. Burns. 1988. *Ringed Seal Monitoring: Relationships of Distribution and Abundance to Habitat Attributes and Industrial Activities*. Final Rep. contract no. 84-ABC-00210 submitted to U.S. Dep. Interior, Minerals Management Service, Anchorage, AK. 101 pp.

Frost, K.J. and L.F. Lowry. 1999. *Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska.* Interim Rep. Cooperative Agreement Number 14-35-0001-30810 submitted to the U.S. Department of Interior, Minerals Management Service, Anchorage, AK. 37p + appendix

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2002. *Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska.* OCS Study MMS 2002-04. Final report from the Alaska Department of Fish and Game, Juneau, AK, for U.S. Minerals Management Service, Anchorage, AK. 66 pp. + Appendices.

Greene, C. 2006. Measurements of the acoustic sources for the shallow hazard survey by *M.V. Henry Christoffersen*, 8 August 2006, Field Report.

Hammill, M.O., C. Lydersen, M. Ryg and T.G. Smith. 1991. *Lactation in the Ringed Seal* (*Phoca hispida*). Can. J. Fish. Aquatic Sci. 48(12):2471-2476.

Harwood, L.A. and I. Stirling. 1992. *Distribution of Ringed Seals in the Southeastern Beaufort Sea During Late Summer.* Can. J. Zool. 70(5):891-900.

Hassel, A., T. Knutsen, J. Dalen, S. Løkkeborg, K. Skaar, Ø. Østensen, E.K. Haugland, M. Fonn, Å. Høines and O.A. Misund. 2003. *Reaction of Sandeel to Seismic Shooting: A Field Experiment and Fishery Statistics Study*. Institute of Marine Research, Bergen, Norway.

IMG-Golder Corp. 2002. *Behavioural and Physical Response of Riverine Fish to Airguns*. Prepared for WesternGeco, Calgary, Alta.

Johnson, C.B., B.E. Lawhead, J.R. Rose, M.D. Smith, A.A. Stickney, A.M. Wildman. 1999. *Wildlife Studies on the Colville River Delta, Alaska, 1998.* Rep. from ABR, Inc., Fairbanks, AK, for ARCO Alaska, Inc., Anchorage, AK.

Kelly, B.P. 1988. *Bearded Seal, Erignathus barbatus*. p. 77-94 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Marine Mammal Commission, Washington, DC. 275 p.

Kingsley, M.C.S. 1986. *Distribution and Abundance of Seals in the Beaufort Sea, Amundsen Gulf, and Prince Albert Sound, 1984.* Environ. Studies Revolving Funds Rep. No. 25. 16 p.

LGL Alaska Res. Assoc. Inc. 2005. *Request by the University of Alaska to Allow the Incidental Take of Marine Mammals During a Marine Geophysical Survey across the Arctic Ocean.* Submitted by University of Alaska to U.S. Department of Commerce/National Oceanic & Atmospheric Administration/Nat. Mar. Fish. Serv. LGL Report TA4122-2, 132 p. Available at http://www.nmfs.noaa.gov/pr/pdfs/permits/healy_iha_app.pdf

Lowry, L.F., K.J. Frost, R. Davis, D.P. DeMaster and R.S. Suydam. 1998. *Movements and Behavior of Satellitetagged Spotted Seals (Phoca largha) in the Bering and Chukchi Seas.* Polar Biol. 19(4):221-230.

Lydersen, C. and M.O. Hammill. 1993. *Diving in Ringed Seal (Phoca hispida) Pups During the Nursing Period.* Can. J. Zool. 71(5):991-996.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000. *Marine Seismic Surveys: Analysis of Airgun Signals; and Effects of Air Gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid*. Rep. from Centre for Marine Science and Technology, Curtin Univ., Perth, W.A., for Austral. Petrol. Prod. Assoc., Sydney, N.S.W. 188 p.

Matishov, G.G. 1992. *The Reaction of Bottom-fish Larvae to Airgun Pulses in the Context of the Vulnerable Barent Sea Ecosystem.* Fisheries and Offshore Petroleum Exploitation. 2nd Intern. Conf., Bergen, Norway, 6-8 April 1992.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-46. In: W.J. Richardson and J.W. Lawson (eds.). *Marine Mammal Monitoring of Western Geco's Open-water Seismic Program in the*

Alaskan Beaufort Sea, 2001. LGL Rep. TA2564-4. Rep. from LGL Ltd., King City, Ont., for WesternGeco LLC, Anchorage, AK; BP Exploration (Alaska) Inc., Anchorage, AK; and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, 46 MD. 95 p.

Moulton, V.D., W. J. Richardson, T. L. McDonald, R. E. Elliott, and M. T. Williams. 2002. *Factors Influencing Local Abundance and Haulout Behavior of Ringed Seals (Phoca hispida) on Landfast ice of the Alaskan Beaufort Sea*. Can. J. Zool. 80:1900-1917.

Moulton, V.D., W.J. Richardson, M.T. Williams and S.B. Blackwell. 2003a. *Ringed Seal Densities and Noise Near an Icebound Artificial Island with Construction and Drilling.* Acoust. Res. Let. Online. 4(4):112–117.

Moulton, V.D., W.J. Richardson, T.L. McDonald, R.E. Elliott, M.T. Williams and C. Nations. 2003b. *Effects of Northstar on Local Abundance and Distribution of Ringed Seals (Phoca hispida) of the Alaskan Beaufort Sea*. p. 5–1 to 5–24 In: W.J. Richardson and M.T. Williams (eds., 2003, q.v.). LGL Rep. TA2702-4.

Moulton, V.D., R.E. Elliott and M.T. Williams. 2003c. *Fixed-wing Aerial Surveys of Seals near BP's Northstar and Liberty Sites, 2002*. p. 4-1 to 4-35 In: W.J. Richardson and M.T. Williams (eds., 2003, q.v.). LGL Rep. TA2702-2.

Quakenbush, L.T. 1988. *Spotted Seal, Phoca largha. p. 107-124 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations.* Marine Mammal Comm., Washington, DC. 275 p.

Rugh, D.J., K.E.W. Shelden and D.E. Withrow. 1997. *Spotted Seals, Phoca largha, in Alaska*. Mar. Fish. Rev. 59(1):1-18. Mitchell, E.D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Board Can. 32:914-91.

Saetre, R. and E. Ona. 1996. *Seismic Investigations and Damages on Fish Eggs and Larvae; an Evaluation of Possible Effects on Stock Level*. Fisken og Havet 1996:1-17, 1-8. (in Norwegian, with an English summary).

Shaughnessy, P.D. and F.H. Fay. 1977. *A Review of the Taxonomy and Nomenclature of North Pacific Harbor Seals.* J. Zool. (Lond.) 182:385-419.

Simpkins, M.A., L.M. Hiruki-Raring, G. Sheffield, J.M. Grebmeier, and J.L. Bengtson. 2003. *Habitat Selection by Ice-associated Pinnipeds Near St. Lawrence Island, Alaska in March 2001*. Polar Biol. 26:577-586.

Smith, T.G. 1973. *Population Dynamics of the Ringed Seal in the Canadian Eastern Arctic*. Fish. Res. Board Can. Bull. 181. 55 p.

Smith, T.G. and I. Stirling. 1975. *The Breeding Habitat of the Ringed Seal (Phoca hispida*). The Birth Lair and Associated Structures. Can. J. Zool. 53(9):1297-1305.

Smith, T.G., and M.O. Hammill. 1981. *Ecology of the Ringed Seal, Phoca hispida, in its Fast-ice Breeding Habitat.* Can. J. Zool. 59:966-981.

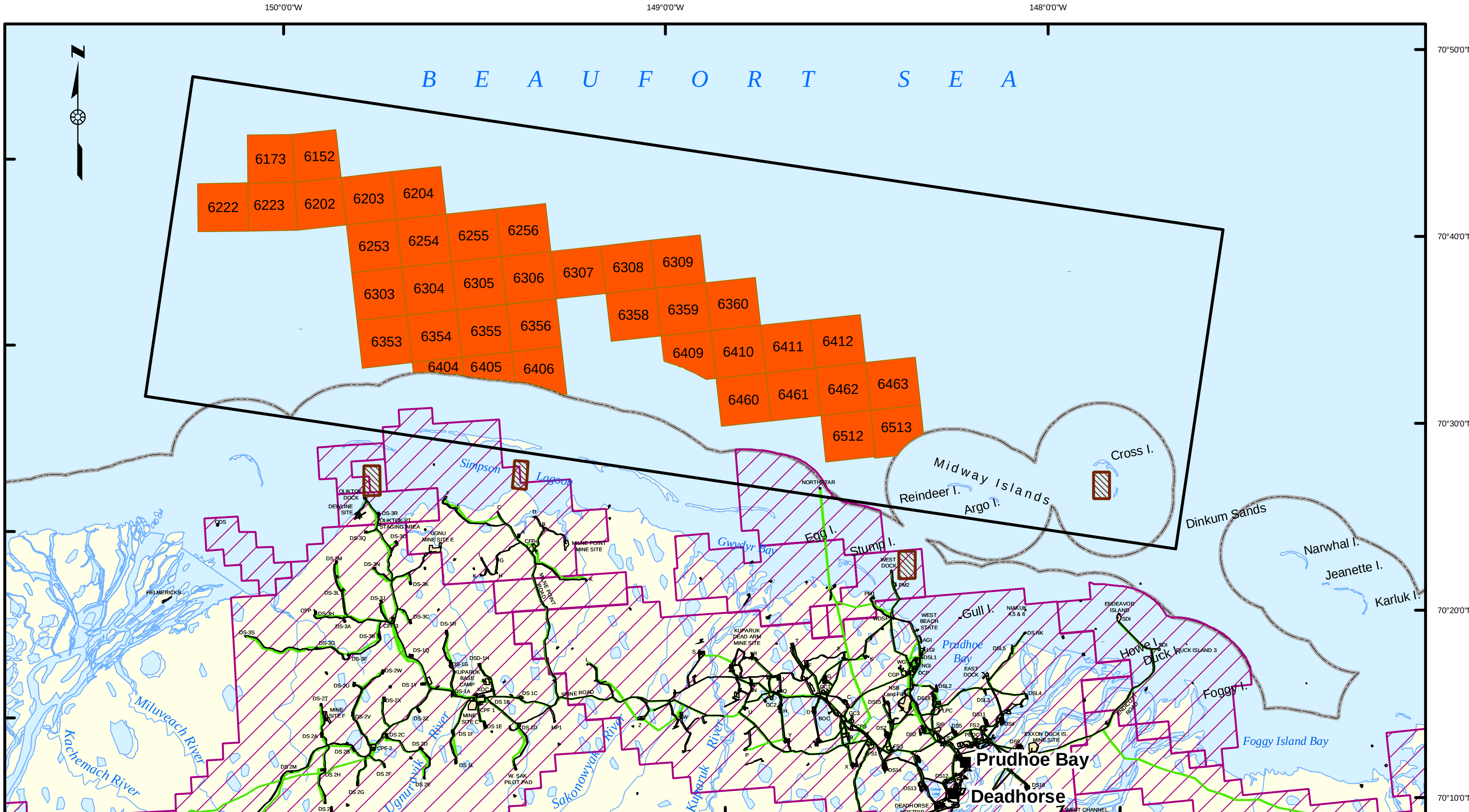
Smith, T.G. 1987. *The Ringed Seal, Phoca hispida, of the Canadian Western Arctic*. Can. Bull. Fish. Aquat. Sci. 216: 81 p.

Stirling, I., M. Kingsley and W. Calvert. 1982. *The Distribution and Abundance of Seals in the Eastern Beaufort Sea, 1974-79*. Can. Wildl. Serv. Occas. Pap. 47. 25 p.

Treacy, S.D. 2002a. *Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2000.* OCS Study MMS 2002-014. U.S. Minerals Manage. Serv., Anchorage, AK. 111 p.

Treacy, S.D. 2002b. *Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2001*. OCS Study MMS 2002-061. U.S. Minerals Manage. Serv., Anchorage, AK. 117 p.

Figure 1
2007 On-ice Seismic Program Area



Shell Lease Blocks

Resource Development Districts*

Prospective Mobile Field Camp Locations (Not to Scale)

Villages

Roads

Pipelines

State-Federal Water Boundary

*All areas outside of Resource Development Districts are Conservation Areas

ASRC Energy Services
Regulatory & Technical Services
3900 C Street, Suite 601
Anchorage, Alaska 99503
Phone (907) 339-5467
Fax (907) 339-5475
www.asrcenergy.com

SHELL OFFSHORE INC.

2007 On-ice Seismic Program Area

SCALE: 0 2.5 5 10 Mi

FIGURE: 2-1

AES-RTS: 15067-199.mxd, 12/04/06, R02

Attachment A
Equipment Specifications

Attachment A

Figure 1: 68,000 lb Vibrator
Model – AHV IV Buggy
Year - 1997 - 2000
GVW - 68,000 #s
PSI - 4.8 #s (loaded)
Peak Force - 61,800
Hold Down - 64,100
Displacement Limit - 5Hz

Figure 2: Personnel carrier
Personnel Carriers
Model – Tucker 1615
Year - 2001 - 2004
GVW - 16,000 #s
PSI - 1.8 #s (loaded)

Figure 3: Equipment trailer

Figure 4: Fuel trailer

Figure 5: Camp trailers

Figure 6: 14,000 lb mini-vibrator